

2002

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Duklan, Karolina and Martin, Michael A., "Communicating Effectively with Words, Numbers, and Pictures: Drawing on Experience" (2002). *Journal of Actuarial Practice 1993-2006*. 46.
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Communicating Effectively with Words, Numbers, and Pictures: Drawing on Experience

Karolina Duklan* and Michael A. Martin†

Abstract‡

In this paper, we discuss techniques for developing effective communication skills, focusing in particular on technical writing, the use of graphics, and presentation. The key principles of effective communication that we propose to actuaries are as follows:

- Identify your audience and consider their needs and abilities;
- Focus on substantive content;
- Choose appropriate communication tools;
- Use language that is simple, concrete, and familiar;
- Integrate text, numbers, and graphics;

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‡This work was carried out with financial support from the ANU Faculty of Economics and Commerce Summer Research Grant Scheme. We also wish to thank an anonymous referee for several insightful comments that improved our paper, and Dr. Steven Stern for his assistance with revising our document into \LaTeX .

- Respond to information complexity creatively.

We focus in particular on the use of graphics as a communications tool as they are an efficient and potentially highly effective means of conveying information. We also describe several common errors in graphic construction—and how to correct them—using examples from the business world.

Key words and phrases: *Communications skills, errors in graphic construction, presentation skills, statistical graphics, technical writing*

1 Introduction

Strong technical skills are a hallmark of the actuarial profession. But at least as important as these skills is the ability of the actuary to communicate information accurately, unambiguously, and effectively. The type of information that actuaries routinely communicate is complex. Yet it must usually be made available to people from a wide variety of often non-technical backgrounds. As a result, there is an enormous burden on the actuarial profession to be able to convey information at an appropriate technical level while maintaining enough detail to satisfy professional actuarial standards. This need is more critical now than ever as the actuarial profession assumes more prominent roles in management where the effective flow of information between organizational tiers can mean the difference between success and failure.

The ability to communicate technical information well is a learned rather than an inborn skill. Peculiarly, most current approaches to actuarial education do not specifically try to teach good communications skills, relying instead on students' abilities to pick up the skills as they need them, usually in the post-study workplace environment. This baptism of fire unfortunately can result in the skills being acquired at considerable cost to employers. They cannot necessarily rely on students who arrive straight from their actuarial studies to be able to communicate as effectively as they would like.

At the root of the problem is the fact that traditional actuarial education is focused largely on the development of excellent technical skills—that is, at getting the calculations right—without too much regard to how the results are presented. To a certain extent this approach is reasonable, in that many traditional classroom/study exercises are canned questions, presented without sufficient background or context to make the presentation of the answer a critical concern. In setting exercises, instructors rarely have the luxury of providing strong motivation or background details for the calculations. Hence, students can

struggle to grasp the importance (both practical and theoretical) of the results. Examinations are conducted under strict time limits, so getting details down on the page emerges victorious over learning the ability to explain ideas to others. Unfortunately, any separation of actuarial calculations from their context can be counterproductive for actuarial students.

Finally, and most importantly, one of the critical aspects of technical communication is the ability to judge the level of the intended audience. At the university level, students write solutions for professors and lecturers, so the amount of technical detail presented in answers is appropriately high. This situation is likely to be very different, however, from that encountered by a professional posed with the problem of preparing a report for a client.

In this paper we attempt to increase awareness among actuaries of the importance of communication skills. In so doing, we develop a set of principles that can be used to promote these skills among actuarial students. Learning good technical communication skills is not as simple as picking up a writing manual from the reference section of the book store. While the skills that make for good technical writing overlap with good general writing skills, they need to be developed with special care. Moreover, technical communication can take multiple forms, including written, oral, graphic construction, and presentation skills. Graphic construction skills are particularly useful, as graphics are an extremely efficient way to present, summarize, and describe large sets of numbers. Fortunately, the same set of key principles governs all these disparate forms of communication.

Three major elements distinguish technical communications by actuaries from more general forms of communications:

- The need to describe complicated mathematical ideas and financial concepts;
- The heavy reliance on graphical tools to convey quantitative information; and
- The need to report on complex numerical data analyses in order to describe stochastic (random) behavior.

Each of these elements places a different burden on the communicator, and each can be a significant barrier for non-technical audiences. So learning principles that specifically target these three areas is essential for actuarial students. Along with these particular skills, actuaries also must develop good general communications skills.

The position of actuaries at the intersection of so many disciplines, including banking, finance, economics, and statistics, places a considerable impost on their communications skills. They must speak the languages of multiple disciplines. As both information-consumers and information-providers, actuaries need to be flexible communicators, able to interpret and analyze intricate and complicated numerical information, yet also able to communicate the results of their labors in a way that is both comprehensive and that their clients can understand. The actuary is in this respect an information intermediary, a vital link between raw, unprocessed data and effective decision-making in the presence of risk.

2 Broad Principles for Writing, Talking, Drawing, Presenting

Several key principles apply to all forms of technical communication. The principles are intrinsically linked. Briefly, they are:

- Know your audience. Communications must be framed with a specific audience in mind. The likely ability and background of the audience is an important factor in deciding the level and type of detail communicated. Speaking to a conference of qualified actuaries about a stochastic model fit for calculating insurance premiums is a very different task from that of justifying use of the same calculation to a group of shareholders. The chosen content and style of communication should reflect that difference. The group of actuaries may be interested in learning about the assumptions underlying the model, as well as in obtaining some detail about the process of fitting and assessing the model against historical data. The language chosen to describe these features could be appropriately technical. The shareholder group, on the other hand, might want an overview of how the new technique may affect customer premiums—the language chosen in this case reflects the broader, non-technical nature of the audience. The cost of misjudging the audience is high: the group of actuaries presented with a broad overview might react with distrust (“What are they hiding? Is this even correct?”) or even boredom (“Surely there is more to this than what we’re being told! Yawn!”); the shareholders confronted with the more technical discussion may react with confusion (“Huh? Why are they telling us this?”) or even anger (“What a waste of time!”).

- Content is supreme. The most polished presentation, whether it be written, oral, or graphical, cannot make up for lack of substantive content. Florid prose in a report, ornate decorations in a graphic, or gaudy colors on a Microsoft PowerPoint® slide may initially attract an observer's eye to what you have to say, but if there is no substance to it, they will just as readily look away. The old adage that one should open one's mouth only when one has something worthwhile to say is an apt lesson in effective communication. This principle holds for all forms of communication. What constitutes "substantive content" will vary from one audience to the next, so understanding the intended audience is an important part of organizing information for presentation.
- Context is vital. It is critical that information is presented in an appropriate context so that it may be interpreted properly and unambiguously. This goal can be difficult to achieve. A number of factors affect the appropriate context, in particular the intended audience and the nature of the content. Every element of technical communication needs to be carefully considered as to how it might be integrated into an effective, efficient presentation. Technical or mathematical arguments, graphics, and data analyses should be used to complement the main message to be presented—not to overpower it, nor as a substitute for it. Complex technical arguments should be motivated carefully in the context of the information to be presented and should be explained intuitively rather than formally unless the specific circumstance (e.g., a meeting of technical professionals) demands a more formal presentation.
- Language should be simple, concrete, and familiar. The information you present needs to be understood easily, and the best way to ensure such an outcome is to use direct, precise language. Here, the word "language" is intended in a broad sense to include text, pictures, speech, and even gestures. Information should be presented specifically for your target audience, using words and expressions familiar to them. For writing and speech, jargon, acronyms, and obscure technical references should be avoided. Sentences should be short without being terse or choppy. Simplicity is also an important quality for graphics, but it is often an elusive goal as simplicity of construction and simplicity of interpretation can be conflicting aims. Nevertheless, graphics should be constructed to be as simple as possible, avoiding redundant or obstructive graphical elements. Oral presentations accompanied by

Microsoft PowerPoint® slides should integrate text and graphical elements in a clean, seamless way, avoiding garish color schemes, flashy transitions, and distracting background patterns. Lack of content cannot be adequately disguised by these devices, and substantive content is diminished by their use. Simplicity is again an important but elusive quality, as oversimplifying a presentation by reducing it to a set of bullet points can lead to a stilted, formulaic perception.

- Integration is important. Most technical information is multifaceted, so its communication should be diverse. Because different modes of communication are effective for different members of an audience, incorporating information as text, graphics, and numbers is not redundant. The use of data should be embraced rather than avoided, as numbers lie at the heart of the content of much technical information. Creative graphical displays of numerical information are extraordinarily valuable. The primacy of text in technical communications is more a reflection of the history of human communications than an inherent strength of text as a means to communicate information. One of the advantages of modern computer systems is their ability to more thoroughly integrate each of the elements of text, images, and numbers into a single document. Of course, integration needs to be implemented in a way that is both creative and stylish so that the outcome is a cogent, aesthetic whole rather than a piecemeal mess.
- Dealing with complex information. Effective technical communication recognizes the complexity of information and responds to that complexity in a creative manner. Size and dimension are two elements of data complexity that pose immediate problems for analysts and communicators. Nowadays, enormous, complex data sets are common (e.g., minute-by-minute stock prices on a portfolio of stocks), so a key task of technical communicators is that of describing complex data patterns as simply as possible. This idea is akin to data compression, whereby gross features of large data sets can be summarized by using relatively few measures; for instance, representing complex returns series in terms of mean and standard deviation measurements. Sound statistical practice is essential if this data compression is to be a successful strategy in understanding large data sets. In such cases, it is inevitable that some information will be lost in the description. Good statistics is about discovering what is important (signal) at the expense of what is not (noise). Graphics are a particularly efficient means of

representing large amounts of complex information. Technical communicators therefore need to develop excellent graphic construction skills.

Almost all interesting information involves relationships between many variables or factors, so techniques need to be developed that allow such high-dimensional information to be displayed on low-resolution, low-dimensional display surfaces. Computer screens, though seen as modern advances on paper, allow for much lower-resolution images than are possible on paper. As a result, the question of how we reduce the dimension of our data so we can *see* what is going on is complicated by the low resolution of the device we use to look at the data. Reducing multivariate data to one or two dimensions involves inherent loss of information. So we need to understand the extent and consequences of this information loss.

Exploring high-dimensional data for relationships between variables also raises complex issues such as cause-and-effect. Graphics should help us to assess whether variables are causally related. Unfortunately, this can be a tricky question, which relies not only on good logic, statistics, and experimental design (where that's possible), but also on the luck of asking the right question in the first place.

Comparison is a vital tool in understanding data and communicating what you see. Good communication invites the question "compared to what?" in response to the size and nature of revealed data structures. Such comparisons promote logical thinking about the nature of relationships within data and assist us in deciding what features of a data set are important. Effective communication is interactive in the sense that it engages the audience to understand and actively participate in the thought processes underlying what is being presented. Their response can feed back into the analysis to allow an even better understanding of the data. Good communication elicits the right questions from the audience. Good graphic construction facilitates useful comparisons through careful thinking about the locations of graphical elements within a single graph or on a single page and through the use of techniques such as small multiples (many graphics located close to one another so that they may all be compared in a single sweep of the eye).

The information actuaries must deal with can be incredibly complex. Effective communicators do not seek to deny the complexity

of the information they describe. Rather, they try to exploit what simpler structures explain the mechanisms underlying the complex data structures.

- Good communication is hard work! Even the most brilliant technical work can be spoiled by sloppy presentation. Poor grammar, crowded or careless graphics, poor organization of presentation layout, and even poor choice of presentation font, are all inimical to good communication. To communicate effectively, you must win your audience's attention—and fight to keep it. If your report is riddled with typographic errors, readers may assume that your carelessness extends beyond your typing. If your graphics are misleading, your audience may distrust other things you say. If your Microsoft PowerPoint® presentation is full of flashy transitions of bullet points, your audience may overlook your substantial content and simply enjoy the sideshow. The solution is simple: practice, practice, practice. Read your own writing and critique it. Think about the presentations or reports that have engaged you, and remember what about them made you pay attention. Then employ these strategies in your own communications.

All the modes of communication described—writing, speech, graphics, and presentations—benefit from the application of these broad principles, but the principles apply in different ways to each of them. In what follows, we explore the various modes of communication and offer particular advice on how to convey ideas effectively.

3 Writing Technical Documents

Beginning, middle, end: the importance of structure: Since mankind first developed language, storytellers have held a revered place in society. Ancient storytellers such as Aesop remain famous today. One of the central tenets of good storytelling is the idea that a good story must have a well-defined beginning, middle, and end. So it is with good technical writing. Without such basic structure, even brilliantly conceived ideas cannot be conveyed effectively. In story-telling, the beginning is used to set the scene, giving readers the chance to understand the basic setting of the story; the important elements of the story unfold in the middle, hopefully engaging the reader's full attention; the ending is the climax of the tale, tying together loose storylines and presenting the moral of the tale. Each of these components is fundamental to the story as

a whole: a tale that begins in the middle is confusing; one without an ending is unsatisfying and frustrating; without a middle, there is no story!

Humble beginnings—“what’s my motivation?”: The storyteller’s craft remains useful for technical writers today. The beginning is particularly important for technical writers; in some cases, it is all that will be read! The introduction to a technical work should motivate the work carefully, summarize the main results, and highlight the important conclusions. In documents typically produced by actuaries, the executive summary plays this role. It is also useful for the introduction to signpost briefly what is in the remainder of the document—some readers may be interested only in a particular section and may ignore the document if they cannot find it easily.

One of the worst sins of technical writing is that of failing to motivate the work adequately. Writers mistakenly believe that they are wasting the reader’s time by giving background to their work. Not at all! By making the purpose of the work apparent immediately, authors make it more likely that readers will read past the first few paragraphs. Authors who fail to adequately motivate their work, fail to engage reader interest and may even prevent some readers from understanding their work.

How should technical work be motivated? The answer lies in the key principles described earlier. First, the intended audience for the work needs to be considered. Ask yourself what the audience can be expected to know about the topic. Anticipate the question “Why are you telling us this?” from the audience. Clearly state at the start what the main issue is, why it is important, and what your solution is—outline the content. For some of the audience, this may be all they want; for others, it will allow them to frame your work in a context that is familiar and important to them. State up front what solutions you are offering. Also try to state what the work does not do.

The power of summary—drawing conclusions: The introduction and the conclusion are equally important. The introduction foreshadows the importance and relevance of the results, and the conclusion must summarize the findings of the work, both technical and practical, and, if possible, make a recommendation based on those findings. The conclusion must be both concise and precise.

It must also be written in an authoritative style and should be self-contained.

Why is technical writing different?: Technical writing, whether it be in business or science or engineering, differs from general prose in three major ways: the use of mathematical or other technical detail; potentially heavy reliance on graphical tools; and the important role numerical work plays in the underlying content. Each element poses a different burden on the technical communicator, but the first element represents the most formidable challenge to the effective communication of ideas. Mathematics and its associated disciplines are akin to foreign languages to many people. To them, comprehending a technical document full of mathematical ideas is difficult. Yet, much of what actuaries do could not exist without mathematics and statistics, and the nature of actuarial business requires that actuaries must frequently communicate with professionals less technically-inclined than themselves. For example, actuaries designing new life insurance products must coordinate their activities with legal professionals who establish the contracts under which the products will operate. How can such disparate groups communicate effectively? The answer lies in the principle that information must be presented in an appropriate context so that the audience can tackle the information in a language and manner that is reasonable given their backgrounds.

So, how are technical or mathematical arguments to be presented? The key principles of audience identification and appropriate context guide us. For example, an actuarial consulting report should contain the minimum amount of mathematical detail necessary for addressing the key consulting questions. Numerical advice should be included as necessary. The client does not wish to (and may not be able to) read detailed mathematical arguments; nor do they need to see every interim calculation. They do wish to know, however, that the recommendations made by the consulting actuary are based on appropriate assumptions and correct, logical thinking. Answers to questions should be framed in the same language as the original question is framed, and abstractions should be avoided. A common problem experienced by novice technical writers is that they forget that the excitement or enjoyment they derived from developing the intricate mathematical arguments that supported their work is rarely shared by the readers of the report. If mathematical arguments disrupt the main message of the paper, then they do not belong there.

Many actuarial reports are intended for both actuaries and non-actuaries. One way in which writers can make technical arguments available is by way of a technical appendix. This idea is well-known in academia. Many academic journals discourage authors from including too much mathematical detail within a paper itself, but offer authors the opportunity to include technical proofs in an appendix. This approach keeps authors focussed on the main issues in the paper, but also allows them to express mathematical ideas freely. We must recognize the huge difference between a published academic paper and a consulting report or a technical report for a client. There remains room within certain types of reports for what is essentially tangential material. How else can interested actuaries recreate what the author has done, either for their own interest or to learn the technique and apply it to their own work? In other types of reports—for instance, client-only documents—there is often no room for such luxuries. Sometimes an unusual amount of detail is necessary, either because the problem demands a mathematical solution and nothing else will do, or because the solution is particularly unusual or novel and becomes, of itself, the subject of interest. Again, context drives the types of decisions to be made here.

When mathematical or technical ideas need to be presented in detail, their presentation makes an enormous difference to the way in which the material is perceived. Most importantly, readers are more able to comprehend mathematical or technical arguments if they are able to grasp the main ideas intuitively. Necessary mathematical complexities should be prefaced by remarks that attempt to explain the goals to be achieved and the means of achieving them in an intuitive way. For example, if a new pricing methodology is best explained by a mathematical statement, then a report introducing that idea should motivate the need for the new technique. It should explain how the development avoids problems with the existing practice. Alternatively, the writer should explain how the new technical developments facilitate a solution where none was previously possible. Such an approach transforms a continuous stream of mathematics into a more fleshed-out argument based on logical principles that most people can understand even if they fail to grasp the mathematical detail itself.

There is a broad literature dedicated to mathematical writing. Its focus is more appropriate to mathematicians or engineers than to actuaries. If your requirements include writing that is heavy

in mathematical notation, however, it is worth reading the style guides produced for the Mathematical Association of America by Gillman (1987) and Knuth (1989) and those produced for the American Mathematical Society by Krantz (1997) and Steenrod et al., (1981). Other notable works in this area include the books by Alley (1986), Barras (1978), and Higham (1993) and the article by Ehrenberg (1982). In addition, there are countless corporate style guides and manuals for writers in business and finance, though these tend to focus on more routine business correspondence and reporting than actuaries usually have to produce.

Writing is not the same as problem solving: One of the difficulties facing novice technical writers is that they seldom have any writing training or experience. Most students write *solutions* rather than reports, and the main drive is to write enough detail in obtaining the correct answer so that a high grade will be awarded. Such a strategy can be disastrous when the same person must write a consultancy report because the parameters governing good solution-writing are very different from those governing good technical writing. No longer is it necessary to recreate the sequence of steps that lead to the answer—the reader probably does not care about those details. Rather, the reader is more likely to care about the interpretation and consequences of the answer.

A useful way of discovering whether your own technical writing style is cumbersome is to read it aloud, as if you were trying to verbally explain it to someone. If the writer finds that they have to stop repeatedly and explain one thing or another, then they have not written the document well. Technical writing places the writer as a filter between raw inputs (usually extremely technical) and comprehensible outputs.

Heuristics: One resort to which technical writers can turn when the detail underlying their work is too technical is to use heuristic arguments that support the claims made in the report. A heuristic argument is one that provides aid in the solution to a problem but is otherwise unjustified—a close analogy is that of trying to solve a complex problem through a series of educated guesses. The correct, justifiable solution will often be much more detailed than an heuristic argument, but is usually much harder to convey to a non-technical audience. Of course, when put to close scrutiny, most heuristic arguments turn out to be incorrect. It is easy to see why this must be: if the heuristic argument were mathematically correct, why could it not be used in a formal sense as a

proof? Nevertheless, heuristic arguments are usually seductive to readers. As long as the writer makes clear that the arguments are informal educated guesses, most readers will appreciate them for what they offer. Writers need to be careful, however, not to put forward heuristic arguments as if they were formally correct, as this will only annoy or confuse the reader who is able to follow the arguments closely.

A similar comment applies to the use of analogies. Most analogies are imperfect. The writer must be prepared to acknowledge where the analogy fails. Otherwise, readers may unwittingly extend it to an area where it does not apply, thereby drawing incorrect conclusions.

The role of jargon: Like many technical fields, actuarial science and its associated disciplines of finance and statistics are awash with jargon. Accrual rates, annuities due, net present values, discounted cash flows, preserved benefits, life tables, mortality, exposure, loss adjustment expenses, loss reserving, rating factors, reinsurance, written premiums versus earned premiums, ...: the list goes on and on. What is worse, each of the main actuarial practice areas (such as life insurance, general insurance, pensions, or superannuation) has its own jargon! Fortunately, actuarial training is broad, and qualified actuaries must be familiar with all of the major fields. Nevertheless, given the increasing complexity of the profession, an actuary in one practice area may find it difficult to converse with an actuary in another. For clients and other business professionals, the situation can be even more frustrating. Further (admittedly anecdotal) evidence that jargon is now a serious impediment to sound actuarial practice is that a cursory search of actuarial consultancy web pages reveals that many consultancies now explicitly promise explanations “in simple English, free from actuarial jargon” as part of their terms of business.

Yet, it is easy to see how beginning actuaries fall into the trap of routinely using jargon. Almost all actuarial education ingrains the jargon indelibly into the lexicon of the training actuary. A report on examination performance for examinations of the Institute of Actuaries in 1997 reads as follows¹ (our emphasis indicated in italics):

Candidates were asked to prepare a letter explaining different interest rates quoted for the same loan. This re-

¹ <<http://www.actuaries.org.uk/pastpapers/1997apr/q2a97rep.pdf>>

port summarizes the main points which the examiners were looking for in the solution. Scripts were expected to read like letters to friends, without jargon and with any technical terms clearly explained. *Many candidates did not achieve this.*

It is easy to spot jargon in a technical report you have written: spell-check it in your word processor (without using any custom dictionaries you have created). Assuming your usual spelling skills are fairly good, most of the words highlighted as incorrectly spelled fall under the rubric of jargon. The best advice is to avoid jargon wherever possible. Of course, the difficulty is that most jargon is usually shorthand that connotes some complicated idea.

The general principle of “know your audience” is critical to deciding whether jargon is appropriate. If the paper or report is to be read by a group of the author’s peers, then it is usually acceptable to use relevant jargon. On the other hand, if the report is to be read by a client, jargon should be kept to a minimum. Writers who follow this advice will often have to create lengthier documents. The increase in length, however, is worth the effort if it means that their reports can be read by the intended audience.

A writer should particularly avoid creating jargon. Unless an idea is novel, the temptation to coin a new phrase to describe it should be avoided. Most ideas, even very good ones, do not warrant the introduction of a new word into the already-crowded actuarial lexicon.

TMA (Too Many Acronyms): Along with the excessive use of jargon, perhaps the most annoying tendency of technical writers is that of creating acronyms. Some use of acronyms is acceptable, provided it is absolutely clear to the writer that all members of the audience are familiar with them. For example, in a report to a government minister, it is acceptable to refer to government departments using well-known acronyms such as IRS or FBI. Other cases are less clear. While it may be perfectly clear to the writer that MoS stands for “margin on services”, but it may be far from clear to a non-actuarial audience. Finally, only a frustrated mathematics graduate would end a technical argument with QED, an acronym so old that the language from which it was drawn is now dead!

4 The Role of Graphics—Modern Cave Painting?

Graphics are a powerful way to communicate technical information. They can summarize and describe vast amounts of information in a compact, efficient, and eye-catching way. Well-constructed graphics can transcend the barriers of language and numeracy because they rely on the almost automatic response of the human brain in interpreting shapes and patterns. Visual information is processed in a different part of the brain than language or numerical information—in much the same way as a modern computer hands off complex video or audio processing to dedicated hardware away from the main processor. Even people without specialized training in pattern recognition or statistics are able to interpret graphs reasonably well. Unfortunately, the reliance of graphics on human visual perception also leads to their greatest weaknesses—the human eye is easily tricked. Thus graphics must be constructed with care lest they lead to misinterpretations and confusion.

Graphics are, by their nature, demonstrative, and the purpose for which they are constructed needs to be clear and unambiguous. Like effective writing techniques, effective graphic construction is a skill that needs to be learned. Howard Wainer, who has published several highly-readable papers on statistical graphics, says that “like motor car driving and making love, drawing graphs is an activity that most statisticians feel they can do well without instruction. The results, of course, are usually disastrous.” While humorous, this sentiment is, regrettably, all too true. Moreover, with the ready availability of graphics capability within computer packages such as Microsoft Excel®, truly abominable yet visually attractive graphics are at the fingertips of anyone who can switch on a computer.

Edward Tufte’s beautifully-crafted and insightful books on visual displays of information (1983, 1990, 1997) belong in the library of anyone working with data. Tufte’s works examine the rationale behind graphics as a tool for communicating information, and they set out definitively and elegantly the key principles of information design and display. Other notable work includes the books by William Cleveland of Bell Laboratories (1985, 1993), who has been at the forefront of developments in statistical graphics, the book and articles by Howard Wainer from the Educational Testing Service (1997, 1984, 1990) whose discussions of the good and bad of statistical graphics are both insightful and entertaining, and articles by Anscombe (1973) and Tukey (1990).

The role of graphics in business and financial communications has attracted some attention in the actuarial, accounting, and finance lit-

erature. Beattie and Jones (1993, 1997) explored the extent to which U.S. and U.K. companies use—and abuse—graphics in their corporate annual reports. Frees and Miller's article (1998) is an interesting discussion on effective graphic design.

The first, and most important, rule of graphic construction is to identify the likely audience for the graphic. It is no coincidence that this is the same "golden rule" as for writing and presenting! Tailoring information for the specific audience is critical for all forms of technical communication. For example, while a survival curve is immediately meaningful to a life actuary, it is unlikely to be an effective graphical tool for a more general, non-statistical audience. Similarly, standard statistical tools such as quantile-quantile plots, while they are models of graphic construction and invaluable statistical analysis tools, are of limited to no use in presentation to general audiences.

4.1 Two Types of Graphics

We will distinguish here two types of graphics: presentation graphics, which are explicitly designed for use in a published report for the consumption of others, and analysis graphics, which are routinely produced as part of a larger analysis and would generally not be part of the ultimate report. Examples of presentation graphics include bar charts, histograms, time series plots, and pie charts. Graphics such as survival curves, quantile-quantile plots, residual plots, and so on are more often classed as analysis graphics. In our present context, most of our comments are applied to presentation graphics, but many also hold true for analysis graphics.

Bar charts and time series plots can be very useful graphical tools, but careful attention should be paid to the principles of good graphic construction even when creating such simple graphics. Pie charts should probably be avoided altogether, as they suffer from several deficiencies that limit their effectiveness. They rely on a reader being able to spot slight differences between areas of sectors of a circle, a feat many people find difficult and unnatural. Moreover, pie charts usually encode only a handful of numbers, and a table is usually a much more efficient way to present such information. Edward Tufte opines that "given their low data-density and failure to order numbers along a visual dimension, pie charts should never be used" (1983). While we agree with Tufte's sentiment, we concede one point in favor of pie charts: they are very familiar to audiences in business and finance, and this familiarity can make them easier to interpret. Nevertheless, variants of pie charts

such as three-dimensional or exploded pie charts and the aptly-named doughnut chart, are anathema to effective communication.

4.2 Rules for Effective Graphic Construction

4.2.1 Substantive Content Should Drive the Need for Graphics

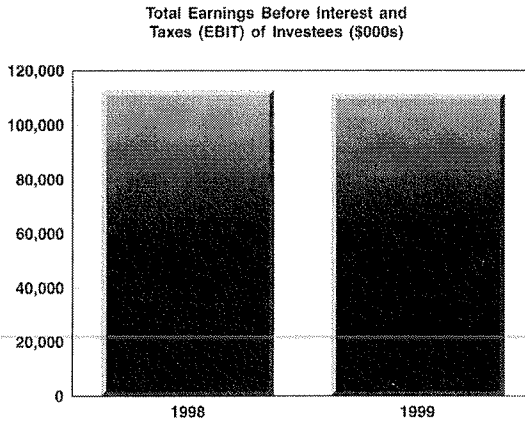
A graphic should represent a significant piece of information. In simple terms, graphics are designed to attract readers' attention, but they must also be meaningful. It makes no sense to encode only a few numbers into an overblown graphic—in these cases, a small table makes more sense, and gives readers direct access to the numbers involved—see Figure 1. Tufte states that “visually attractive graphics also gather their power from content and interpretations beyond the immediate display of some numbers. The best graphics are about the useful and important, about life and death, about the universe. Beautiful graphics do not traffic with the trivial” (1983). Of course, decisions as to what is important are highly subjective!

Lack of purpose in graphic construction is betrayed by several tell-tale signs. The first is low data density, a measure of how much data is represented in the space allotted to the graphic. We have seen numerous annual reports that force the reader through a forest of bar charts or pie charts, each of which represent only a handful of numbers. A better option is to use a single, moderate-sized table.

Graphics adorned with excessive decoration also can conceal a lack of content. Figure 2 depicts such a case, where “chartjunk” (i.e., extraneous decoration with no informational content) dominates the graphic.

Good graphics answer the question “Why?” as well as the questions “What?” and “How?” about a set of data. Where possible, they should reveal cause-and-effect relationships. Two excellent examples of how graphics might achieve this goal are given in Chapter 2 of Tufte's book *Visual Explanations*. He shows how graphics were instrumental in the discovery of the means of cholera transmission and how graphics, had they been more thoughtfully constructed, may have prevented the launch of the ill-fated 1986 space shuttle Challenger.

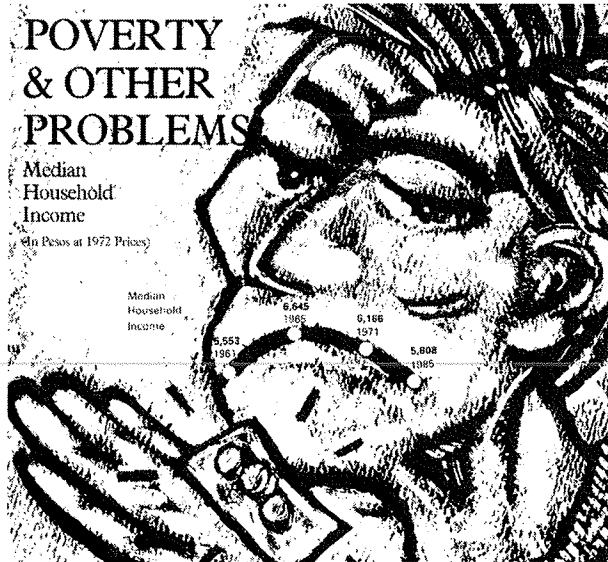
Figure 1
A Two-Point Bar Chart



This graphic shows how a whole page of a report can be taken up describing just two numbers! This bar chart encodes only two numbers—about 112,000,000 for 1998 and about 110,000,000 for 1999. The bevelling and greyscale gradient on the bars reduces their perceived height, while the small amount of data encoded makes it a shame to waste an entire page in a report. A small, two-number table, or even a short sentence, would suffice. The report from which it was drawn contained eight similar graphics, each describing just two numbers. (*Source: ©Australian Venture Capital Association Limited—Year 2000 Yearbook.*)

How well a graphic achieves its purpose can be difficult to judge, as graphics can show both what is present in the data and what is not. As a result, graphics can surprise and delight us by making apparent features of the data that were not originally anticipated. Detailed data analyses involving graphs are best thought of as iterative processes. Preliminary, mainly graphical exploration of the data is followed by a deeper investigation based on model formulation, fitting, and assessment. Graphics are an integral part of each stage of the analysis. Individual graphics also benefit from an iterative approach to their design, whereby each element is carefully considered in the context of its interaction with other graphical elements.

Figure 2
The Dominant Face



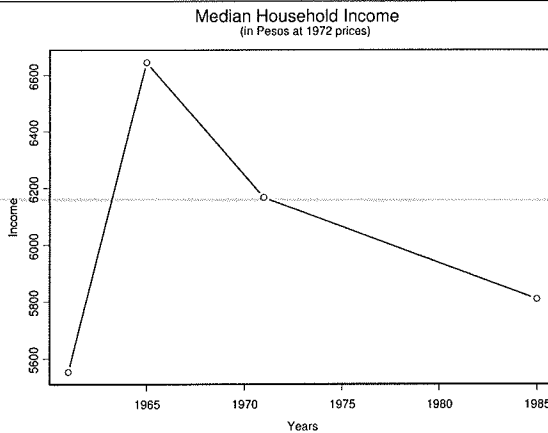
This graphic encodes just four numbers: 5553 in 1961, 6645 in 1965, 6166 in 1971, and 5808 in 1985. The decoration dominates the graphic to such an extent that it misrepresents the data hideously. Note that the horizontal distance that represents the 14 years between 1971 and 1985 is shorter than the preceding intervals of four years, presumably so the "mouth"—a decoration—remains in proportion with the face. Also, the final amount (5808) appears smaller (positioned lower than) than the initial amount (5553). Curiously, the authors have applied some good statistical practices—the amounts reported are medians rather than means, and the currency is adjusted to 1972 levels. (Source: ©MBC (Makati Business Club) Economic Papers, September 1988.)

4.2.2 Good Graphics Promote Comparisons

Good graphics must be based on sound logical principles and good statistical practice. Graphics must not lie! Almost all interesting and important arguments involving numbers are relative—how big is one number *compared with another number*, and what does the difference in their size mean in the context of the problem at hand? Difference and change are the drivers of almost all decision-making. Comparison is the

most important tool of scientific inquiry that we have. Good graphics reflect the same principles as sound, logical reasoning, invoking wise comparisons in a way that is both natural and aesthetic. There are several ways in which graphics can be constructed to facilitate meaningful comparisons:

Figure 3
The Dominant Face Reworked



A re-working of Figure 2 shows a shape that is not mouth-like at all! In fact, it appears as if the rate of decline is slowing. Unfortunately, the long time period between measurements makes it difficult to sustain this argument.

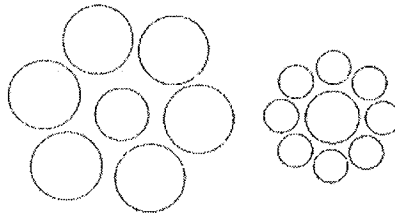
- If two curves are to be compared, consider plotting their difference or their ratio rather than simply putting both curves onto a single axis. This technique forces comparison along a horizontal baseline and takes advantage of the fact that humans can perceive even slight deviations from straight lines, especially horizontal and vertical ones;
- Plots should be augmented by the addition of visual elements such as fitted lines wherever possible so that patterns in the data are easily recognized;
- Graphical elements that are close to one another are more easily compared than those that are far apart. As a result, placing multiple lines on the same set of axes or multiple graphs on a single

sheet of paper is an effective way to promote comparison. The latter idea, referred to as the *use of small multiples*, is a particularly effective way to describe large amounts of multivariate data efficiently. The concept behind small multiples is that a large number of similar graphics can be explored within a single eye span, so even small differences become readily apparent. The worst case is where several graphics to be compared are spread over several pages.

Mere proximity of graphical elements does not guarantee wise comparisons, as the optical illusion in Figure 4 shows. Figure 5 shows an example of the use of small multiples to compare the marketing budgets of several different kinds of firms.

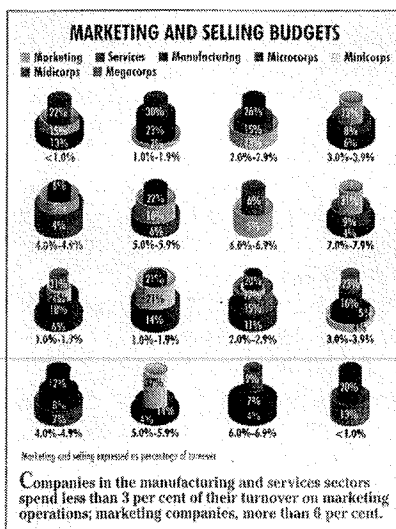
An excellent graphic design which uses small multiples is the scatterplot matrix, which depicts all two-dimensional relationships among pairs of variables in a multivariate data set. This graphic manages to render high-dimensional information into two-dimensions and does so in a way that allows the reader to quickly explore each panel for evidence of correlation—see Figure 6 for an example.

Figure 4
An Optical Illusion



Which of the two “middle circles” is larger? Most people answer that the one on the right is larger, when in fact they are the same size. Size is judged in relation to the outer array of circles in each case. The left middle circle is small compared to the circles surrounding it, while the right middle circle is larger than its surrounding circles. The result is an incorrect perception in comparing the two middle circles.

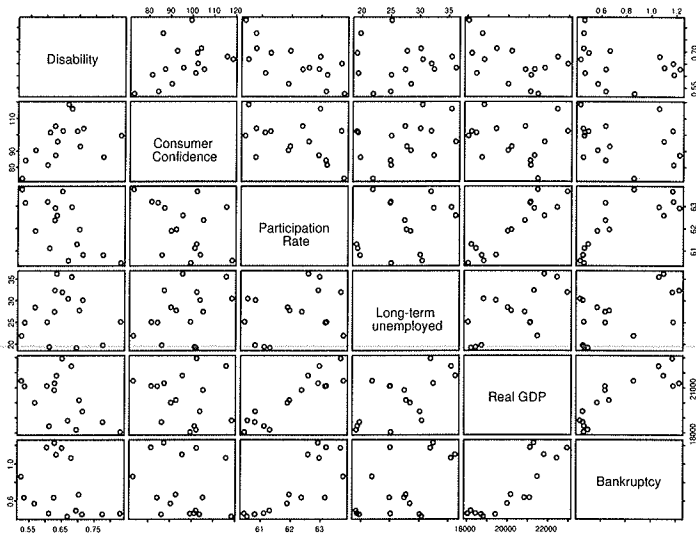
Figure 5
An Imperfect Use of Small Multiples



Here, 16 small graphical elements are placed close to one another to facilitate comparison between them. Unfortunately, the nested cylinders' size bears scant relation to the numbers they represent. Overall, a good idea (small multiples) is ruined by poor choice of symbols (nested cylinders). Note also the heavy use of jargon ("midicorps", "microcorps"). A caption describes in three lines what the graphic was unable to impart. (Source: © *Business Today* magazine, Feb 22–Mar 6, 1998, page 67.)

The graphic design of Figure 6 is good because it allows the viewer to examine many two-dimensional slices of the high-dimensional data space quickly. Care must be taken, though, in interpreting the graph, as interesting directions in the data may not include those involving only two variables at a time. Also, while the graphic is capable of showing association between variables, it cannot address the question of whether such relationships are causal. The establishment of causality must be more than a visual process—it also requires careful logic and, typically, good experimental design.

Figure 6
A Scatterplot Matrix



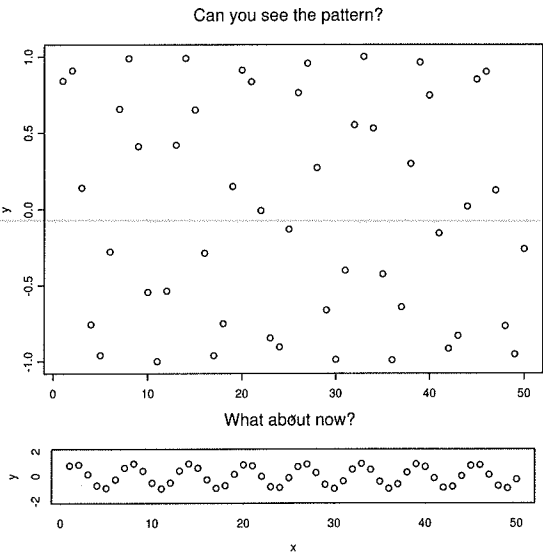
A scatterplot matrix exploring the relationships between various economic indicators and a disability index (number of disability insurance claims scaled by a measure of exposure). Covariates included were a measure of consumer confidence, employment participation rate, long-term unemployment, real GDP per capita, and a total bankruptcy rate. The data were reported by Service and Ferris (2001). There appears to be an association between the disability index and each of the other variables—see the top row of the array. There also appears to be several relationships among the covariates (e.g., Bankruptcy and GDP, Participation Rate and GDP, Participation Rate and Bankruptcy), which makes separating the individual effects of each variable difficult.

4.2.3 Graphics Should Be Designed to Be Aesthetically Pleasing

Proportion, perspective, and scale are important elements of graphic construction. Graphics need to be eye-catching without being garish. Every design element of a graphic should be considered in terms of how it may affect the viewers' ability to perceive the content of the graphic. The aspect ratio of a plot, the ratio of the height of a graphic to its width, can affect how the content of a plot is perceived—Figure 7 shows such a case. Also, careful attention needs to be paid to the layout of graphics

within a page. For example, two histograms sharing the same set of horizontal axes and bin-widths should be aligned vertically rather than side-by-side to facilitate easier comparison of their shapes.

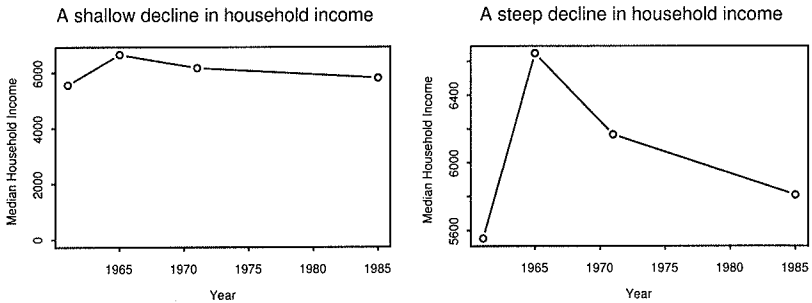
Figure 7
The Importance of Aspect Ratios



Each of these two graphics plot the same data, yet the pattern (a simple sine wave) only emerges clearly in the lower graphic. What has changed? Aspect ratio and choice of vertical axis.

Seemingly benign design aspects, such as choice of axes, are critical to drawing graphs that are easy to interpret. For example, the practice of including the zero point on all axes reflects a poor design choice, as zero may be nowhere near the bulk of the data. Unfortunately, such choices are often not left to users, as popular computer packages such as Microsoft Excel® offer the feature of axes including zero as a default for some choices of line graph (and, strangely, not for others). While the default can, of course, be changed, many users will never exercise this choice. Figure 8 shows two versions of a graphic depicting household income data from Figure 2. Which is the more truthful?

Figure 8
Median Household Income Revisited

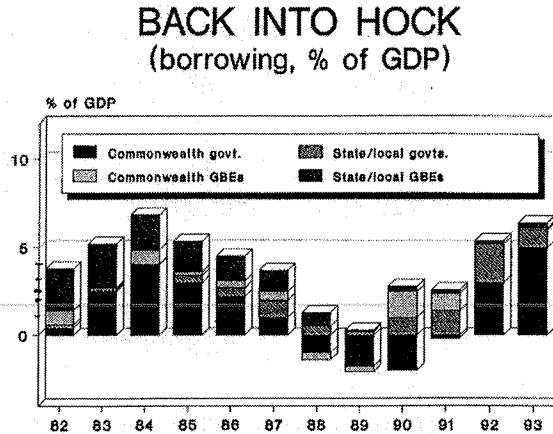


The forced inclusion of 0 on the vertical axis of the left plot de-emphasizes the extent of the change in income over time.

Other design factors that affect graphical perception include choice of plotting symbol and the use of colors or shadings. A good general principle is that when a graphical element is used to encode numbers, that element and the information it encodes should be of the same physical dimension. For example, bar charts violate this principle because they encode single numbers as two-dimensional objects (bars), rather than as one-dimensional objects (lines). Three-dimensional bar charts are even worse, as they encode a single number using a three-dimensional object. The introduction of redundant dimensions promotes ambiguity in how one interprets the graphic (does the depth of the 3-D bar have any meaning?), and ambiguity is the enemy of effective graphic construction. Three-dimensional elements also risk introducing unusual perspective effects into graphics, the overall impact of which can be unexpected—see, for example, Figure 9.

Color is a potentially effective tool in graphic construction, though its use has been historically low. Color needs to be used carefully, as they are not strongly visually ordered, whereas grey scales are. As a result, grey scales are preferable in many instances. Moreover, up to 5% of the male population suffers some form of color-blindness, so designs should not rely exclusively on color. Shading patterns such as cross-hatching can also lead to unusual and distracting optical effects such as moiré vibration.

Figure 9
An Unusual Perspective
On Public Sector Borrowing in Australia



Unfortunately, the introduction of a spurious third dimension into the plot causes bars that have negative borrowing components to appear as if they are in front of the other bars—they have leapt into the third dimension! (Source: © Report on Public Sector Borrowing, Australian Public Service, 1994.)

Consistent choices improve the impact and comprehension of graphical forms. We have seen annual reports in which several flavors of bar charts (stacked, three-dimensional, bevelled) have appeared on consecutive pages of the report. This practice causes readers to constantly switch frames of reference and makes comparison across graphics difficult.

4.2.4 Graphics Should Be Simple In Interpretation and Perception

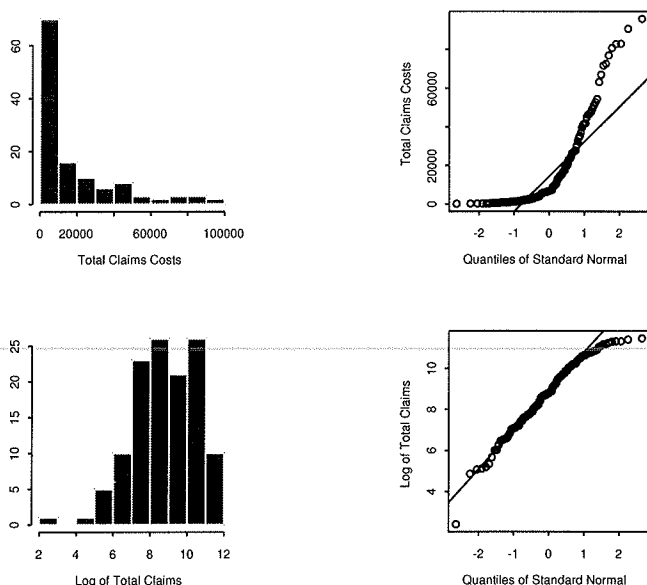
Of the four principles discussed, this one is the most elusive. It is not always possible to attain graphics that are both simple to visually perceive and simple to interpret. A case in point is the use of transformations—data are often transformed so that when they are summarized by a graphic, the main features are readily apparent. Yet, when a viewer comes to interpret the graphic, they must do so remembering that a back-transformation is necessary before any conclusions

can be drawn. To attain perceptual simplicity, one must keep in mind the way human visual perception works. For example, people can see very easily when a pattern of data points deviates from a straight line, but may be unable to perceive similar scale deviations from a curved line. Equally, it is perceptually easier to observe deviations from horizontal or vertical lines than it is from lines at arbitrary angles—this is the principle that makes residual plots such an effective tool for assessing the quality of a statistical model fit.

Quantile-quantile plots, designed to assist in detecting when data do not plausibly arise from a bell-shaped distribution, are an example of excellent graphical construction. They achieve simplicity in perception, but they are not simple to interpret without training. The graphical premise underlying quantile-quantile plots is that data are transformed onto a particular scale where departures from normality are associated with non-linear patterns in the plot. Discovering such patterns is much easier, perceptually, than the process of deciding whether a histogram of the data looks bell-shaped. Most viewers cannot adequately envisage what “bell-shaped” means, whereas deciding whether a pattern is linear or not is easy. The difficulty arises once the visual pattern has to be interpreted in the original context. Inexperienced viewers make the mistake of interpreting the pattern as meaning that the original data have a linear relationship with some other variable—that is, they attempt a literal interpretation of the shape of the plot. Only when the link between distribution shape and the associated Q-Q plot is made do viewers realize the correct interpretation—see, for example, Figure 10.

Other design elements also impact the simplicity of graphics. Impediments to simplicity include the abundant use of abbreviations on a plot, overuse of legends and different line types (e.g., dotted, dashed, dot-dash lines), and excessive decoration.

Figure 10
Are Motor Insurance Claims Normal?



Baxter, Coutts, and Ross (1980) report data on total cost of claims for 128 combinations of claimant age, vehicle age, and vehicle type categories. Histograms of total claims for the 128 categories and the log of total claims are shown at the right, with associated normal Q-Q plots on the left. The distribution of total claims is highly skewed to the right (indicated in the Q-Q plot by a non-linear, concave-up curve), while the distribution of log total claims is closer to bell-shaped, but slightly skewed to the left (notice the slight concave-down curvature in the Q-Q plot).

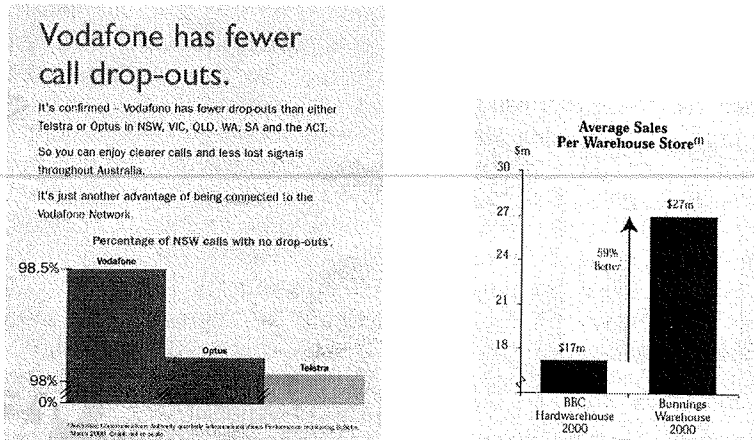
4.3 Major Errors in Graphic Construction

4.3.1 Misrepresentation of Data

The most common error in graphic construction is the use of graphical elements that either deliberately or accidentally fail to accurately represent the data they encode. The simple paradigm to which all graphics should adhere is that graphical elements that represent numbers should be drawn in proportion with those numbers. This straight-

forward rule is breached surprisingly often. Two simple cases are where bars are not started at zero but at some other, arbitrary value, or where long bars are broken; see Figure 11 for two examples. In each instance, the relative heights of the bars are not in the correct proportion—the relevant visual metaphor is broken.

Figure 11
Broken Bars



Bar lengths should be proportional to the numbers they represent! In the left graph, the largest bar should be only 1.005 times as large as the smallest bar, but visually the ratio of their sizes is about 5. In the right graph, the larger bar should be about 1.6 times the length of the smaller bar, but visually the ratio of their sizes is about 6. In each case, the error favors the company producing the graphic. Amusingly, the fine print on the left graphic admits that the graphic is not drawn to scale—why bother to print it then? (Left: © Vodafone, Source: Australian Communications Authority, March 2000. Right: Wesfarmers Retail Pty Ltd share offer for Howard Smith, June 2001.)

This case can be contrasted with that discussed in Figure 8 for line plots, where the most relevant visual element was the *slope* of the line rather than its *height* above the baseline. Hence, the lack of a zero baseline is not as critical a problem for line plots as it is for bar charts, which use relative heights of the bars to visually encode the numerical information to be transmitted.

Figure 12 shows another obvious misrepresentation where the time scale is seriously distorted. Ironically, the headline for this graph, when translated, reads “A picture is worth a thousand words”—unfortunately, almost all of the words we can use to describe this graphic are critical.

A key error common with financial data is the failure to adjust monetary amounts for factors such as inflation. Invariably, if inflation is not accounted for, strong positive trends in variables such as spending are generally overstated.

Another, more subtle form of misrepresentation is data aggregation prior to graphing the data. Aggregation is a form of data smoothing that allows for long-range trends to be observed in volatile data. If the data are aggregated too coarsely, important short-run information can be lost. For example, reducing quarterly or monthly data to annual data by aggregating quarters/months into years can cause significant seasonal variations to be obscured. In extreme cases, this approach can lose the most important or interesting information.

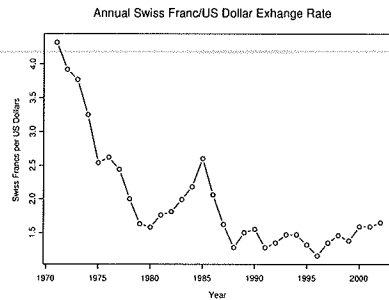
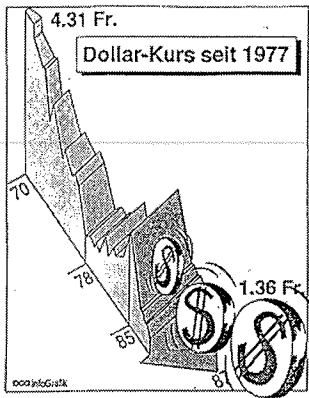
As a simple illustration, in some classes of general insurance, claims are likely to rise in certain seasons (e.g., storm and fire insurance claims will tend to rise in summer and decline in winter), and these critical trends will be missed if data on such claims are annualized. Of course, the amount of aggregation appropriate for a particular set of data depends on the question being asked. In the preceding example, annualized data would be appropriate if the goal of the graphic were to display the overall growth in claims over the last ten years. If, on the other hand, finer detail were required, the amount of aggregation would need to be reduced.

Smoothing and aggregation inherently involve loss of information. The key to a satisfactory graphical outcome is to identify what extent of information loss can be tolerated for the question at hand. A straightforward way to avoid misrepresentation is to experiment with differing amounts of smoothing before deciding which graphic gives the most useful and truthful account of the data. Remember that good graphic construction is a process of iterative refinement—the search for truth in graphics is neither short nor easy.

Other subtle misrepresentations in bar charts include failure to begin bars on a common baseline (making it harder to judge their relative sizes) and varying the width of bars (the perceived size of a bar is related both to its height and its width, so equal width bars should always be used)—see Figure 13.

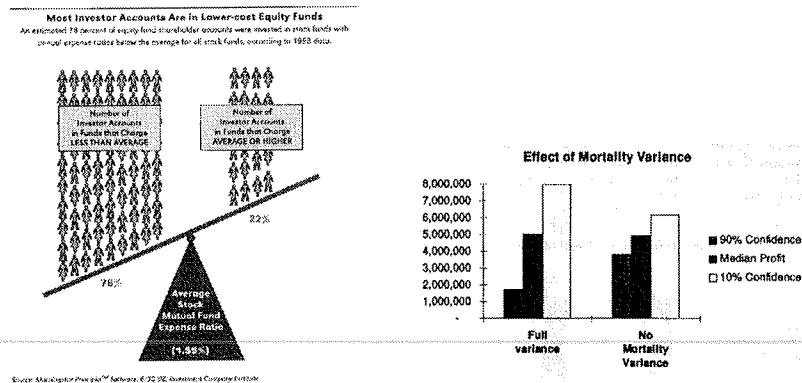
Figure 12
Scale Distortion

**Eine Grafik sagt
mehr als tausend
Worte.**



In this graphic, the time scale is so distorted (the two years from 1985 to 1987 are represented on the time scale using the same distance as for the seven years from 1978 to 1985), and the viewing angle and perspective so distracting that the graphic is almost useless as a visual tool for understanding the U.S. dollar/Swiss Franc exchange rate. It is extremely difficult to judge the extent to which the Swiss Franc had recovered its value in 1985 after the initial drop in the late seventies. Also, the width of the exchange rate curve increases as the curve moves down the page. The strong visual impression is that the relative size of the dollar to the franc is growing over time (see the increasing width of the curve, and the decoration of growing dollars rolling off the end of the curve). Of course, during the period under study, the currencies generally moved in the opposite direction. A simple time chart would communicate the correct information much more efficiently and unambiguously—see the plot on the right, which clearly shows the 1985 recovery of the franc to over half its 1970 value. (Source: Computerworld Schweiz, 1989, © Cash magazine.)

Figure 13
Bars with Varying Baselines and Widths



The graphic on the left includes bars with oblique baselines and varying widths, making the judgement that the bar on the left is about four times the size of the bar on the right difficult. The graphic on the right includes bars of varying width and color, complicating an accurate visual assessment of their sizes. (Source: (Left) © Investment Company Institute, Morningstar Principia™ Software, 6/30/98. (Right) Lang (1998), *Australian Actuarial Journal*.)

Perhaps the most common form of data misrepresentation occurs when bar charts are constructed using decorative elements other than fixed-width bars to represent data. One only has to pick up a copy of *USA Today* or browse their website² to find a vast array of exotic shapes (e.g., hot dogs, bears, arms, legs, hats) presented as bars in a bar chart. The problem with these decorative elements posing as bars is that in order to make them look real, their widths must remain in proportion to their height, so that as their heights grow so do their widths. As a result, although the relative heights of these bars are correct, their relative perceived sizes—usually their areas—are not. This design variation distorts viewers' perception of the data, and hence misrepresents the true situation.

²See, for example, <<http://www.usatoday.com/snapshot/news/snapndex.htm>>

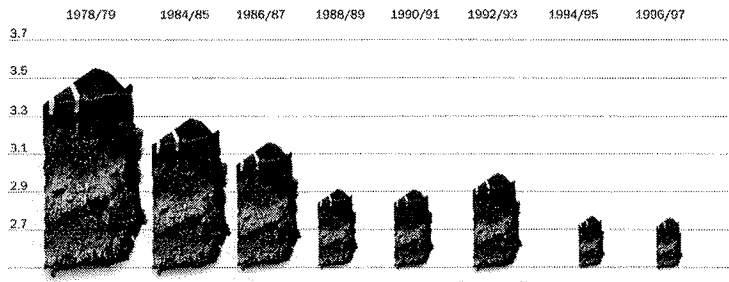
4.3.2 Redundant Dimension

Graphical elements should have the same dimension as the information they encode. So, a single number A is better represented by a line segment with length proportional to A than by a square whose side-length is proportional to A . This preference is based on what we know about human visual perception—when people are presented with a two-dimensional figure such as a square, they usually perceive its size as its area (A^2) rather than its side-length or diagonal length.

The introduction of spurious dimensions into a graphic also causes ambiguity. Some viewers will interpret characteristics in that extra dimension as carrying meaningful information, while others will not. The use of three-dimensional bars in bar charts also can create unusual depth and perspective effects. If the useful information in a bar chart is only represented by the height of the bars, then the bars should be rendered as lines, not bars, and certainly not as three-dimensional blocks, or, worse, cylinders or cones. In the case of three-dimensional bars, the perceived size of objects is their volume (proportional to A^3), rather than their heights (A). The use of fixed-width, two-dimensional bars is acceptable only because their areas are in the same proportion as their heights and because such bars are aesthetically nicer than simple lines. Nevertheless, varying the widths of two-dimensional bars introduces spurious information into the redundant second dimension and hence the perceptual properties of the graphical element. Some examples of problems arising from redundant dimensions are shown in Figures 14 and 15.

Not only does the problem of redundant dimension create distortion of information for viewers of a graphic, but it also slows their comprehension of the information in the graphic. An interesting article by Fischer (2000) explores the issue of whether redundant dimension in bar charts materially affects the speed of comprehension among viewers. He finds that there is, indeed, a significant slowing of cognition for graphs containing such irrelevant depth cues. The last chapter of Cleveland (1985) describes a number of other visual perception experiments with analogous results.

Figure 14
Expenditure on Australian Schools as Percentage of GDP 1978–1997.



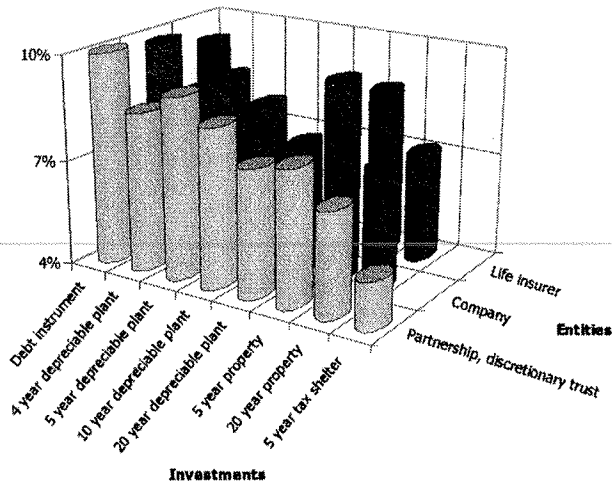
Here bars are presented as pieces of a cake (a three-dimensional object). To maintain the proportions of a piece of cake, bars are of varying width. Other notable errors in this graphic include a non-zero baseline for bars and a distorted time scale at the left of the graph. As a result of these errors, the ratio of perceived size for the largest to the smallest piece of cake is about 50 (using volumes) and about 15-20 (using areas), while the actual ratio of their sizes should be $3.5/2.75 = 1.27$. (Source: Australian Education Union)

4.3.3 Excessive Decoration

Graphics should be eye-catching, but not to the extent that the real information is drowned out by the extraneous decoration. Tufte refers to such elements as chartjunk. Decorations cannot rescue a graphic based on low or no substantive content. When decorations dominate a graphic, the graphic becomes itself a decoration, and it ceases to be a useful tool for communicating information. Worse still is when substantive content is hidden or distorted by decoration, because viewers may misinterpret or even distrust the information they receive.

Figure 15
Hidden Bars and Oblique Baselines

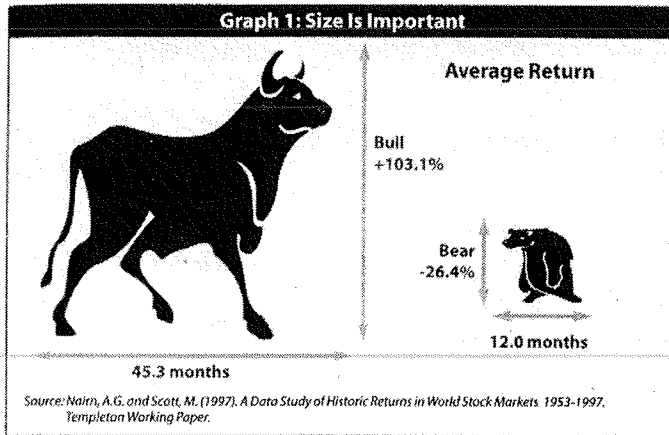
Figure 3.1:
Inconsistent treatment of entities and investments
yields fundamental distortions



Some fundamental problems arising from redundant dimensions include hidden bars and oblique baselines. Unfortunately, many of the measurements for life insurers cannot be recovered at all from this graphic, as they are completely obscured. The third dimension on this graph could be collapsed so that grouped side-by-side bars for each entity could be presented on a two-dimensional bar chart with investments on the horizontal axis and percentage on the vertical axis. (Source: ©Australian Taxation Office (1999), *Tax Reform: not a new tax, a new tax system.*)

Put simply, if the information is important, you do not need to highlight it with ornate decorations—the substantive content you provide will hold the viewers' interest. Examples of excessive decoration are given in Figures 16 and 17.

Figure 16
Of Bulls and Bears



The graph encodes four numbers in almost the worst way possible. The decoration *is* the graphic! The information to be conveyed is that the average bull market lasts about four years and has a real return of about 100%, while the average bear market lasts about a year and has a real return of -25% . It is not clear how this comparison is served by depicting a bull that is, perceptually, about 10-15 times the size of a bear. This two-dimensional rendering of the data is largely meaningless. (Source: © *Professional Investor* magazine, October 1997.)

4.3.4 Multiple Vertical Axes

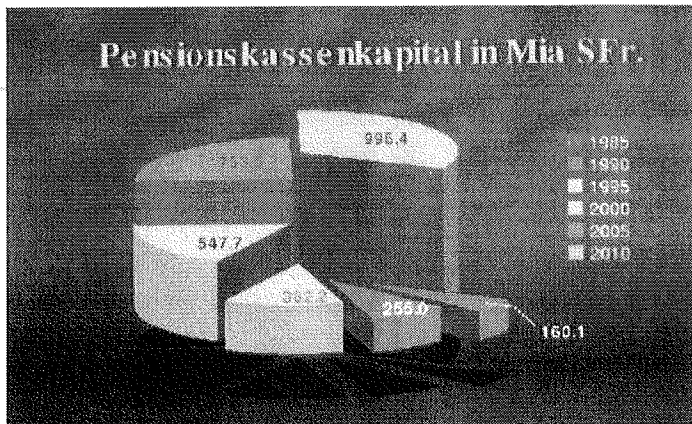
Authors commonly construct graphics in which several data series are plotted on a single plot with vertical axes on each side of the plot corresponding to the different series. While this device saves some space, it almost always introduces visual effects that encourage inappropriate comparisons between the two series. If two series are thought to be related, scatterplots are a far better tool for assessing any relationship.

Intersections between lines on a plot with multiple vertical axes are particularly easy to misinterpret. Visually, intersections between the series suggest a sudden change in the ordering of the two series—one suddenly appears larger than the other. Of course, the effect is usually

spurious, as the series are on entirely different scales, and the intersection is an artifact.

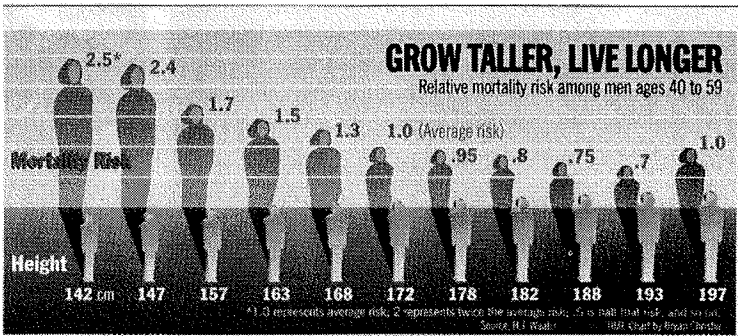
Similarly, varying slopes on a plot with multiple vertical axes lead to a misinterpretation as to the relative rate at which the two series are changing. The rate of change of each series is completely dependent on its vertical scale, so relative rates of change in a plot with two vertical scales are meaningless—by changing the scale on one of the axes, one can change the viewers' perception of the plot completely.

Figure 17
A Pie Spiral of Pension Fund Capital

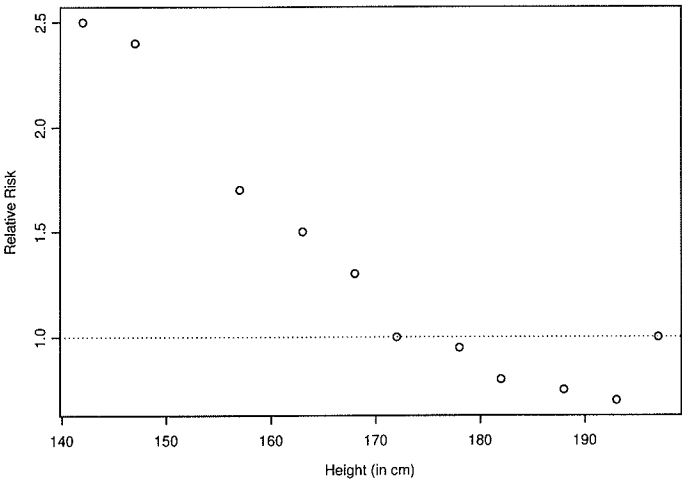


Each step of the spiral represents the amount of pension fund capital at five year intervals. The amount of capital is encoded as the heights of the sections, which appear to be in roughly the right proportions. Yet, the angle subtended by each section also systematically grows as the eye moves up the spiral, so the perceived size of segments—measured as volumes—grow much faster than they should. The amounts given are cumulative, though this is noted nowhere on the graphic. Conventionally, time is depicted as increasing from left to right. Here time grows in a spiral, purely as a decorative effect. The graphic encodes only six numbers. (Source: © Computer Graphix AG, *Info*, January 1990.)

Figure 18
Grow Taller, Live Longer

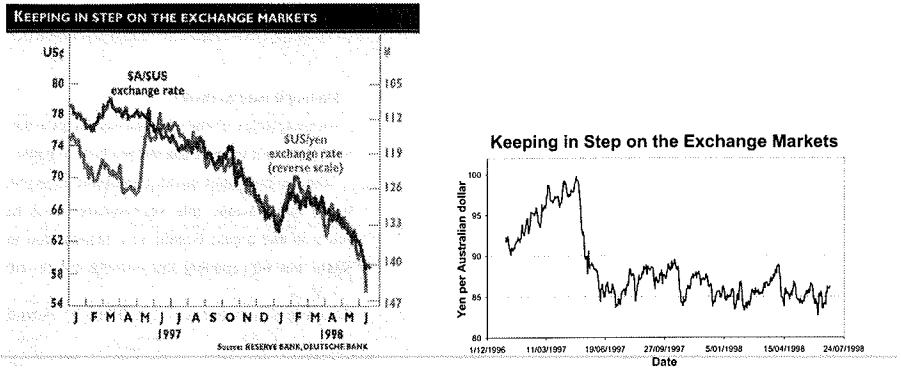


Grow Taller, Live Longer



The upper graphic attempts to show the relationship between height and relative mortality risk by plotting two series, height and mortality, on the same graph. Although the heights are presented in ascending order on the plot, they are shown as equidistant from one another when, in fact, they are not. Graphics must respect the fact that numbers have not only order but also magnitude. Apart from the initial error of plotting multiple, different-scaled series on the same graphic, the graphic suffers a number of other weaknesses. These include the lack of explicit vertical axes, choice of stylized human figures as bars (redundant dimension), and ambiguity about where the shadow bars begin (do they begin at the feet of the human bars, or at the line separating red background from blue background?). The heights in the data are almost equidistant from one another, so the shape of the mortality curve depicted in the original graph is almost, but not quite, right. The lower graphic is a much better graphic for examining the relationship between height and mortality. It is a simple scatterplot relating the two! A horizontal reference line was added to the new plot at height 1 to reflect a

Figure 19
The Yen and the Australian Dollar



The graphic on the left shows the yen declining in value at about the same rate as the Australian dollar between January 1997 and June 1998. The differing scales for the two exchange rates mean that the actual rates of change were different. Note the right vertical axis is in *reverse* numerical order. If, as the title of the graphic on the left suggests, the goal is to show that Australian and Japanese currencies were moving together, a simpler and more direct method would be to plot the Yen/\$A exchange rate against time as in the right graphic. (Source: (Left) © *Business Review Weekly*, June 1998.)

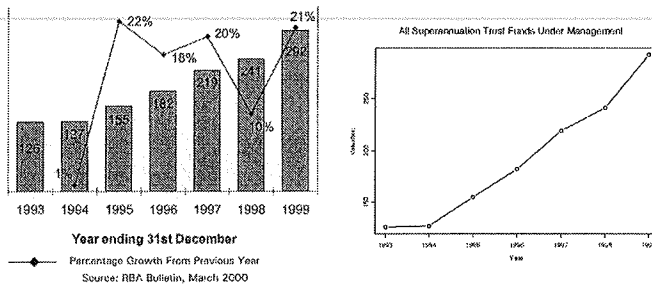
Figure 20 shows an example of where two series plotted on the same graphic interact particularly poorly, even though the series are just two ways of considering the same information.

4.3.5 Breaking with Established Conventions

We all view graphics through a set of inherent filters that allow us to perceive information quickly and easily. Some of these rules are obvious, such as lines going upward on a page representing increase while downward sloping lines connote decrease; words should read left to right; when comparing graphical elements, larger objects represent larger numbers than smaller objects; and so on. Other rules are less obvious: time on a plot evolves from left to right on a horizontal axis and from bottom to top on a vertical axis; white represents absence while black represents presence; an object in the background of another, same-size object will look smaller. When these conventions

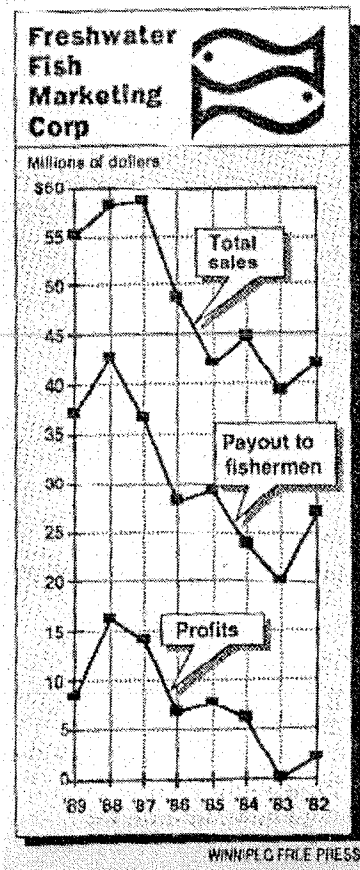
are broken, we become confused as our fundamental assumptions are challenged. Comprehension is also slowed as visual information usually processed automatically must be analyzed anew. Conventions exert enormous impact on what we can understand easily; we should not break them frivolously or carelessly. When you construct a graphic, think about what you *see* and relate it to what you *mean others to understand* from the graphic. Linking the visual to the cognitive is an essential part of graphic construction. Figures 21 and 22 show how breaking conventions can radically alter—or even reverse—viewers' perceptions of a graphic.

Figure 20
Avoid Mixing Raw Amounts and Percentages



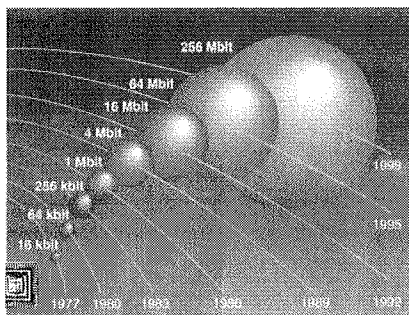
The graphic on the left depicts a series of raw amounts (bars) and a series of percentage growth rates from previous years (line). Although both series are presented on the same plot, explicit labeled vertical axes are not provided (numbers are instead presented on the graphic itself). The plotted line is like a second derivative of the original series, a quantity that is not easily visualized. The two plotted series are visually at odds—although the series of raw amounts always grows, the superimposed line plot suggests regular declines. In fact, the declines depicted are in the relative *rate* of growth. The left graphic also suffers other construction errors. The mixing of graphical elements (bars and lines) is visually jarring. The lack of explicit vertical axes is also a problem as it forces the data to be presented directly on the graphic (which begs the question of why a graphic is needed at all). A more effective, and simpler, way to view the data depicted would be to present a simple line chart of the original annual valuations—see the graphic on the right. Variations in growth rate are easily seen in such a graph as the line either moves up or down from its previous angle. (Source: Carrett and Stitt (2001), *Australian Actuarial Journal*.)

Figure 21
Fishing for Profits



A quick look at this graphic suggests that sales and profits are falling for the Freshwater Fish Marketing Corporation. Time to get out of business? Hardly! A closer examination of the time axis at the bottom of the plot reveals that time is plotted in *reverse* from 1989 to 1982 – in fact, profits and sales have risen since 1982. (Source: © Winnipeg Free Press, obtained from <http://www.stat.sfu.ca/~cschwarz/Stat-301/Handouts/Descriptive/BadGraphs/seafood.gif>)

Figure 22
Exponential Increase?



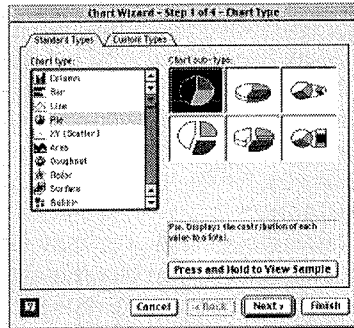
The speed of microchips has increased exponentially since 1977. Yet the curve traced by the spheres in this graphic is turning in the opposite direction to that expected of an exponential increase. The *fact* of an increase is apparent, but the *nature* of the increase is not. Also, instead of increasing in equal-sized steps from left to right, the time axis in this graphic is traced by a set of concentric curves. The spheres have volumes that are not in the same proportions as the numbers they represent. The graphic is more decorative than informative. (Source: © *Scientific European*, October 1990.)

4.3.6 A Modern Problem: Too Much Power, Too Much Choice

Ten years ago, the task of producing graphics was the domain of the graphic artist. Unfortunately, graphics artists were more often trained in art not in statistics. As a result, many information graphics were beautiful to look at, but did not convey information accurately. Today, almost anyone with a personal computer can produce professional-looking displays. Popular spreadsheet programs can produce a dizzying array of graphics. For example, Microsoft Excel® can produce 14 standard types of graphics—column, bar, line, pie, scatter, area, doughnut, radar, surface, bubble, stock, cylinder, cone and pyramid—each with multiple variants for a total of 73 basic designs plus numerous custom charts. Yet only three of them—the basic bar/column chart, line chart, and scatterplot—are worthy of common use.

Bar and column charts differ only in whether the bars run horizontally or vertically. We prefer vertical bars as up is a more natural direction to connote increase or aggregation than left-to-right. Three-

Figure 23
Choices, Choices



Microsoft Excel®'s Chart Wizard offers an astonishingly long list of graphical possibilities. Pictured are the six variants of pie charts: basic, 3-D, basic with sub-pie, exploded, 3-D exploded, and basic with sub-bar.

dimensional variants of these charts always introduce redundant dimensions and should be avoided. Stacking bars makes comparisons of their components difficult, as each component has a different baseline as we move from bar to bar. Variants that replace fixed-width bars by other geometric figures such as cones or pyramids suffer redundant dimensions, but also fail because the shapes chosen are narrower at the top than the bottom, so the bar's height is de-emphasized.

Line charts are particularly useful for representing data developing through time. Our preference is for line plots rather than bar charts for time series data, as the joining of adjacent points in a line plot emphasizes the movement of the series through time. Three-dimensional variants of line charts are particularly hard to interpret. Area charts, created by filling the area under line charts, are generally ineffective. It is usually the height of the line above a baseline, not the area under the line, that encodes the appropriate information. Ambiguity about which of these features is the relevant graphical element in a line chart creates different perceptions for different viewers.

Stock charts are a variant of bar or line charts that track high, low, and closing stock prices for a particular stock over a number of days. These charts share the properties of bar or line charts, with the further advantage that professionals in finance are familiar with their interpre-

tation. Nevertheless, there is little to distinguish them from simple bar charts or line charts. We do, however, recommend line charts be used for stock prices rather than bar charts to emphasize the flow of stock prices over time.

Pie charts fail largely because although humans perceive straight lines effectively, our ability to perceive subtle differences between sectors of a circle is unreliable and variable. Three-dimensional, exploded, and doughnut varieties of pie charts only complicate our perceptual difficulties. Tables of numbers prove more effective.

Scatterplots are useful for exploring two-dimensional relationships, and higher-dimensional information can be encoded through the appropriate choice of plotting symbols. For instance, a relationship in four dimensions can be represented in two dimensions by plotting the first two variables as coordinates of a scatterplot, but instead of points, plotting rectangles whose height and width are proportional to the third and fourth variables, respectively. In a similar vein, Microsoft Excel®'s bubble charts use circles to encode a third variable. However, bubble charts are not effective because the values of the third variable are encoded as the diameters of the circles, whereas the perceived size (area) of a circle is proportional to the *square* of its diameter.

Radar charts (also known as star charts) can be useful for visualizing continuous multivariate data, but the resultant shapes need to be interpreted carefully. They are best used in small multiples, where a large number of radar charts can be compared quickly to assess variability in multivariate data. Surface charts, including perspective plots, contour plots, and wireframe variants, may be useful for three-dimensional data, but have limited use in other contexts.

It is important for creators of graphics not to confuse artistic sophistication with graphic sophistication. In graphic construction, simpler is better. Decorative or realistic effects such as three-dimensional bars or complex shadings can dramatically affect viewers' perceptions. Remember, your content will drive interest in your graphic, and lack of content cannot be concealed by flashy visual effects. Modern software gives us unprecedented choice when constructing graphics—exercise that choice wisely, always keeping in mind the needs of readers.

5 Presenting Numbers in Technical Communications

Actuaries convey complex numerical information to other actuaries, professionals from other disciplines, and clients. From simple reporting of numbers to complex sensitivity analyses and financial simulations, the types and range of numerical information to be communicated are broad. These requirements impose a burden on actuaries because many less-technical audiences regard numerical analyses and simulations as a "black box" from which the desired outcome emerges. Actuarial techniques are iceberg-like in that only a small fraction of the work performed is displayed in detail. How the results of many hours of complex calculations can be pruned into a manageable, easily explained form is a major problem faced by the profession. Actuaries cannot assume that policy- and decision-makers are familiar with common actuarial terms. All communications must be cast in as simple and familiar a language as possible. Wise use of graphics is part of the answer to this problem, but non-graphical techniques are also important.

The most important rule for communicating numerical work is that the author must present the results in a way that addresses the original question or issue in the same language as that in which the question was raised. The divide between formal, numerical answers and plain-language answers must *always* be crossed by the communicator, and the audience must *never* be forced to take this responsibility. Plain-language answers will be appreciated by the audience no matter what their technical level. Even for those at the highest technical levels, communications that summarize numerical results in a direct, easy to understand way will be regarded as insightful and useful.

The second rule for communicating numerical work is that, although a plain-language approach should be used in summarizing the work, it is nonetheless important to recognize the power of numerical arguments and, therefore, not to avoid using numbers. Numbers carry meaning beyond what can be transmitted using only words and images, and their inclusion remains an important part of technical communications.

The key is to strike a balance between detail and summary. Identifying the needs of the audience is critical to knowing what balance will work well, but some broad advice can assist communicators to find the right mix.

- Simulations and sensitivity analyses need to be broad enough to draw proper conclusions. Numerical results also need to be supported by appropriate rigor. Analyses that do not consider enough cases or which are based on inappropriate assumptions usually lead to incorrect conclusions and warped logic. If a new methodology is to be recommended for use with real data, it should be tested on real data. We have seen new techniques only tested on data drawn from three theoretical distributions that foundered when they were applied to real data. If real data cannot be obtained, then simulation studies must be broadened to reflect real-world experience. Similarly, sensitivity analyses must reflect the types of departures from set assumptions that are both credible and probable in the real world. Whenever new methodology is to be presented, the onus *always* rests with the presenter to demonstrate the merits of the new technique.
- Actuary, heal thyself! Actuaries are well-trained in statistics, but all too often we see in papers and reports large tables of numbers presented, undigested, accompanied only by a dismissive statement that the author's conclusion is "clear from the information presented in the table". No matter how careful or correct the calculations underlying the creation of such tables of numbers, the content of the tables must be analyzed with care, using proper statistical techniques. All conclusions should be delineated and specified. Nothing should be declared as simply "clear from looking at the table" as it puts the burden of analysis on the reader. Analyses of results often show the stated conclusions to be far from "clear given information in the table"!
- Actuarial modeling is an iterative process that generally cannot be described in a technical report or paper. More likely, the report will contain the final results of a modeling procedure, with little or no discussion of what other models were considered, what diagnostics were performed through the analysis, and so on. It may be acceptable to detail the model-fitting process, but in that case it is critical to also mention what assumptions underlie the analysis and to defend their tenability. Diagnostic procedures should only rarely be reported in the final document; authors should resist the temptation to report their results as a step-by-step description of the analysis. Any data uncovered as unusual should be noted, especially if they have been removed in the course of the analysis.

Consider a general insurance setting in which the actuary is required to implement and describe a stochastic model for claims experience based on a number of rating factors. First, the actuary needs to consider carefully what assumptions will underlie the analysis. These assumptions need to be stated in describing the model, along with a reasoned discussion of choice of rating factors, availability and source of data, and so on. In this case, a generalized linear model for claims experience might be appropriate, and a formal statistical analysis of building a model would proceed. The actuary might present the results of the model fitting, perhaps in a table, together with p -values for the various rating factors. While the formal modeling process is complete, the actuary's task in communicating the information has just begun. Readers cannot be required to draw their own conclusions from a set of p -values alone—many non-technical readers will be unable to make such judgments unassisted. The actuary must describe the final model in plain language, note what rating factors were found to be important in the analysis, and note which factors were not. Any anomalies that arise from the modeling process, such as factors that were considered a priori important but which were not included in the final model, need to be explained, in plain language. Finally, the actuary must draw a proper conclusion, which may include a formal recommendation that the new model be considered for evaluating future claims experience.

6 General Issues in Effective Writing

As technical writing is a subset of writing in general, the principles that govern good writing undoubtedly apply to technical writing. Many of these principles are covered in general style guides, such as the University of Chicago's *The Chicago Manual of Style* (1993) and Strunk and White's *The Elements of Style* (1979).

Grammar is important: Nothing annoys readers more than reports that are poorly written from a grammatical perspective. Writers should ask a colleague to read their work. Writers should use the automatic spell-checking and grammar-checking facilities built into modern word processors. All reports should be proof-read carefully, as spell-checkers will not find all mistakes.

We are reluctant in this forum to enter the ever-raging debate on the use of "I/We" in technical papers, and we feel that this is more a matter of style than of correctness. Masculine pronouns, and the ubiquitous "he/she", should be avoided in favor of plural pro-

nouns (they, their) to minimize the risk of alienating a large proportion of the audience. Other more formally grammatical issues, such as active versus passive voice and issues such as maintaining the appropriate tense within a paragraph are also important, but are more than adequately covered in popular style guides.

Precise, concise, wise—keep it simple: Writers should adopt a precise, concise style. Strategies that promote such a style are those that avoid complicated grammatical structures. Writers should avoid tangential comments or asides, particularly when the writing style required is formal. Writers need to think critically about what they are saying, even down to the level of small phrases.

Each writer has their own personal style, and it is futile to try to produce automatons who each write in a uniform, simple manner. It is possible to adopt a straightforward writing style without sacrificing your individuality. An easy step is to re-read each document you write and proof it, searching not only for grammatical and technical errors, but also for stylistic gaffes. These can be just as damaging to your report's ultimate fate as even the most grievous technical error.

Words and phrases to avoid: Certain style guides essentially prohibit the use of long or difficult words. We argue that these are matters more of style than substance. Simple, short sentences that use primarily simple, straightforward prose are unlikely to be ambiguous. Unfortunately, they also tend to be fairly dry and uninteresting to read. When writing, one should always have access to a dictionary and a thesaurus. (We simply point our web browser to <<http://www.dictionary.com>>.) Examples of words that can and should be avoided (with alternatives shown in parentheses) include: utilize (use); facilitate (help); endeavor (try); terminate (stop); transmit (send); demonstrate (show); initiate (begin or start); necessitate (need); elucidate (explain); and so on.

Don't be a draft dodger! These days, composing documents at the keyboard is widespread. Of course, such electronic innovations have done wonders for productivity, subjectively measured in terms of pages of output. But they have also been partly responsible for a sharp decline in the ability of people to carefully *craft* their documents.

The benefits of on-line composition are obvious: changes to your document can be made easily; sections can be added or deleted

at a whim; grammar and spell-checkers can eradicate typographical and other errors; and “intelligent agents” built into modern software can automatically structure documents into a variety of familiar and impressive formats. It is easier than ever for the written word to look professional. The same cannot always be said, however, for the quality of the content! No software yet available can alter the fact that writing is a *craft* that benefits from reflective thought and practice. No matter how skilled the writer, the first draft of a piece of technical work is rarely ever acceptable as a finished work. Indeed, the second, third and fourth drafts often need polishing. Good writing requires not only skill, but also patience. A writer must be prepared to read and re-read a document several times and make changes as appropriate before the document can be considered for submission.

Titles, abstracts, and references: Many reports are judged solely on their title, summary, and reference list. For many written works, these are the only parts of the document that are widely read.

- **The Title:** Titles should be brief and descriptive. Obviously, these two goals are at odds. The temptation to incorporate all the ideas from the report into the title should be avoided. The main question authors should ask themselves before selecting a title is “what would make *me* want to read this paper”.
- **The (Executive) Summary:** Material for the summary needs to be chosen even more carefully than the title. It needs to cover the main ideas from the report without overwhelming the reader with unnecessary detail. A good basic structure is to have a separate short sentence describing each of the main ideas in the report. The summary generally should not exceed a single page in length. Mathematical or technical symbols are usually not useful in the summary.
- **References:** Where a technical document is meant for wide distribution, the reference list is an important part of the work. Almost all technical work is derivative in some sense, and it is critical that the relevant research of others be cited fairly and appropriately. Only directly relevant items should be cited, unless the paper is a review article. Writers should be careful not to unduly reference their own previous works.

7 Effective Presentation Skills

Just as critical as the ability to write well is the ability to present technical information to a live audience. Although the principles of effective communication also apply to live presentations, a number of factors distinguish this form of communication. Good skills in this area are increasingly important as the actuarial profession evolves and actuaries assume more prominent management roles within companies.

Timing is a dominant issue. Speakers should always adhere to time limits. Arrive early for your talk as it allows you to check that any equipment works, allows you to relax a little, and often gives you the opportunity to make yourself familiar with some of the audience.

The live component of your presentation is ephemeral—unlike writing, there is usually no chance to edit mistakes or to recast part of the presentation. On the plus side, there is a spontaneity associated with speaking to a live audience that cannot be captured in writing or other forms of communication.

Presentations afford the communicator a unique opportunity to directly interact with their audience, either explicitly through a genuine dialogue or implicitly by adjusting the presentation on the fly in response to audience reaction. A good communicator can sense the mood of the audience and respond by varying the tempo of the talk—by focussing on particular issues that seem to pique the audience's interest or de-emphasizing topics of less importance. The ability to skip ahead in a presentation or to slow down gives the communicator an enhanced opportunity to engage the audience's attention.

The forum of a live presentation often allows the speaker to use language less formal than in a written report. While speakers still need to structure what they say according to good grammatical rules, natural speech is considerably more free-form than writing. Other forms of non-verbal communication such as eye-contact, gestures, and facial expressions evincing emotions (e.g., smiling!) are possible with live presentations. If they are used wisely they can make the presentation come alive more than any written report can.

Audiences for live presentations are precious. If you lose an audience during a talk, you may never get them back. Live audiences are notoriously variable, with factors such as time of day having a significant impact on their behavior—a successful pre-lunch presentation could be a post-lunch bomb! Finding the right level for a presentation is a critical but tricky proposition. Never assume an audience knows nothing and speak down to them—this will alienate a proportion of the listeners. Use plain language, and avoid jargon and colloquial expres-

sions. Regard the audience as intelligent, but potentially uninformed, and fashion your presentation accordingly. Look at your audience's faces and eyes, and judge from their reactions whether you are pitching your material at the right level—and adjust your presentation if necessary.

Try to learn beforehand the culture of the group to whom you will be presenting. Will the audience interrupt to ask a question or will they wait until the end of the presentation? Will there be any particular people to watch—e.g., a senior manager who always asks a question out of left field—and think beforehand how you will handle that situation should it arise. Unlike writing, live communications can be fluid, and you will be judged on both your presentation and on how you react to the moment. The best approach is to be enthusiastic and confident. If there is a lectern available, do not use it! Move freely and engage the audience whenever possible. Speak at a comfortable volume, modulating your voice as you would when talking to a friend. Above all, be natural and as relaxed as possible.

7.1 Structure Your Presentation

Just because a presentation is live does not mean that it should not be carefully scripted. Like all forms of communication, it should be structured in a way that is logical and clear. Begin by stating the overall goal of your presentation. Make it clear why what you are discussing is important, to whom it is important, and what your solution is. Audiences conditioned to sound-bites need to know the main message of your talk up front.

Whatever your preferred mode of presentation—overhead, Microsoft PowerPoint® slides, physical charts, or just plain speech—always prepare a handout for the audience. A handout is a tangible reminder of your presentation, it gives it a life beyond the hour in which you speak, and it makes it possible for people who cannot attend the presentation to receive your message. A handout also signifies that you stand behind what you say—you are willing to commit it to paper and, hence, to close scrutiny. Because the audience will be taking the handout with them, it needs to be prepared carefully.

First, the handout must contain your name and contact details—if a question occurs to a person the day after your talk, they will want to contact you. It also must contain the date of the presentation to place what you say in some historical context. The handout should be a document prepared specifically for that purpose, not just a copy of your slides or a copy of the full report. The handout you prepare

should summarize your talk, cover each point you raise in plain language, and include any key graphics or tables on which you want the audience to focus. The handout is also a safety valve in case you forget to mention an important point. It is a special-purpose document, not an afterthought to the presentation. It will represent you far longer than the presentation will.

Live presentations are inevitably less-structured than written documents. This aspect of presentations is a double-edged sword. Some presenters fail to recognize that some structure is critical, and their presentations typically meander and never make any real impact. Good presenters impose structure, but can take advantage of the freedom offered by the live environment to adjust their presentation in a variety of ways that promote audience engagement. For instance, judicious repetition of key ideas can be extremely effective in delivering the required message.

7.2 The Mechanics of Presenting

Presentation has an element of presence and a physicality not found in written communications. It usually relies heavily on technology for delivery, and logistical preparation is an important component of giving an effective presentation. How material will be shown (overheads or Microsoft PowerPoint®?), how your output should look, what the room is like (lighting, layout), how large the audience is likely to be, even the time and day of the presentation, are all critical questions in planning your talk.

Most business presentations are made using Microsoft PowerPoint®, although some holdouts still use overhead projectors. If you are using Microsoft PowerPoint®, it is best to bring your own laptop computer and your own data projector. This practice avoids difficulties related to operating system differences (Windows/Macintosh/Linux), logins (you may not have an account on the system at the delivery site), and versions of available software. You should bring two copies of your presentation on separate disks (or on CD) as well as a copy appropriate for use on an overhead projector. Be prepared for the worst!

- **Overhead slides:**

Overhead slides should be typed rather than handwritten and should not be too crowded as people at the back of the room need to be able to read them. Dark ink should be used to promote visibility. Avoid at all costs what Tufte refers to as the “trapezoidal strip tease,” the practice of concealing the overhead and revealing

the contents one line at a time. This technique discourages the audience from engaging as it forces them to follow the presentation at an artificially imposed pace and it encourages linear thinking.

- **Microsoft PowerPoint® slides:**

Presentations delivered in Microsoft PowerPoint® suffer most of the same problems as presentations delivered on overheads, plus some new problems related to the features of the software. Microsoft PowerPoint® gives users an incredible number of choices for the display of information, but our recommendation is to use many of the features conservatively. The interface for your presentation needs to be selected carefully, paying particular attention to the following issues:

- *Colors:* Color schemes need to be chosen thoughtfully to present the appropriate image. Dark writing on light backgrounds is recommended, as it provides the best readability at a distance. Light writing on dark backgrounds is also a reasonable, high-contrast choice, but is less legible at a distance. Other color choices are usually disastrous, particularly red writing on blue backgrounds which results in uncomfortable vibration effects. Also, combinations of red and green cause particular difficulties for members of the audience who are red-green colorblind.
- *Transitions, Advances, and Fades:* Microsoft PowerPoint® provides multiple sophisticated visual and sound effects that can be used in transition between slides or even from one line within a slide to the next. These effects are flashy, distracting nuisances. The audience is not there to see a movie, complete with special effects. Transitions used to advance from one line to the next within a slide are the Microsoft PowerPoint® equivalent of the trapezoidal strip tease, and they should be avoided.
- *Fonts:* As far as possible, use standard, sans serif fonts for your presentation. These fonts have maximum readability at a distance and are guaranteed to be available on any standard computer on which you can run your presentation. Odd or decorative fonts should be avoided at all costs—they play the same role in presentations as chartjunk plays in graphic construction—that is, they de-emphasize your content.
- *Backgrounds:* Also avoid the use of distracting logos or backgrounds to your slides. Company logos should be discreet

and tastefully placed. People only need to know where you are from once, so large distracting reminders on every slide are overkill. Similarly, Microsoft PowerPoint®'s default collection of clip-art is familiar to most people.

- *Layout*: Slide layout is important, and Microsoft PowerPoint®'s default layouts are reasonable, though they favor the use of dot points more than we recommend. Dot points promote simplistic, linear thinking. We suggest a more flexible strategy that uses ideas such as hyper-linking creatively to allow the presentation to respond to audience reactions. An approach that invites audiences to ask questions and make comparisons assists in turning the presentation from a monologue to a dialogue. Slides that mix text, graphics, and numbers tend to be more interesting and promote such dialogues. Care must be taken not to clutter the slides too much.

7.3 Speaking Strategies

Speaking before a live audience can be a traumatic experience. Good speakers use this nervousness to their advantage by channeling the resultant energy into an enthusiastic delivery style. Effective communication is fostered if the audience feels comfortable with the speaker. Good eye contact, natural gestures, and a relaxed attitude will help create such an atmosphere. If possible, have the lights on in the room when you are delivering your presentation. This choice will make it easier to establish and sustain eye contact with your audience.

The best presentations are those delivered in a steady voice using a natural tone, much as if you were involved in a conversation with another person. Being natural will help you avoid nervous habits such as uttering "umm's and aah's" or fidgeting. The best way to avoid these nervous habits is to realize the power of silence in a presentation. Pauses between sentences or ideas can be extremely useful, as they give the audience time to absorb what has just been said. Pauses also can be used deliberately to give more effect to the preceding statement. Silence can be golden. Fidgeting can be controlled by holding a laser pointer or a pen, but such props should be used sparingly.

Finally, always be ready for questions from the audience. Never react with surprise, dismay, or disdain. Your overall performance may be judged by how you handle direct interactions with the audience. Many questions are directed at drawing attention to the questioner, not embarrassing the speaker. Treat all questions with respect. Be prepared to take time answering them and to admit you do not know the answer if

necessary. Questions can enliven your presentation. Encouraging them sends the signal that you are confident and competent. A useful strategy is to plant a colleague in the audience who will ask a pre-arranged question. This approach can induce others from the audience.

8 Conclusion

While the content of most actuarial communication is technical, the craft of communicating such information effectively is as much an art as it is a science. Just because the information is structured and detailed does not mean that you cannot exercise creativity and style. Nevertheless, technical communications must conform to certain guidelines to be effective. Understanding your audience's abilities and needs is critical to the successful communication of your work. Good technical communications result from meaningful content described in a straightforward way. Further, the best technical communications recognize the power of combining text, images and numbers in a compelling presentation.

Finally, spend some time in the shoes of your audience. Learn from your own experience in listening to and reading the communications of others. Remember what attracted you to presentations you enjoyed and what repelled you from those you disliked. Attempt to emulate the techniques used in the good presentations. Try to be as objective as possible in assessing how effective your communication style is. If you cannot be objective, ask a colleague to assist by critiquing your style.

Learning effective technical communication skills is a difficult and frustrating task, but the rewards of possessing such skills are well worth the price of obtaining them.

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